KEITHLEY

Model 2361
Trigger Controller
Instruction Manual

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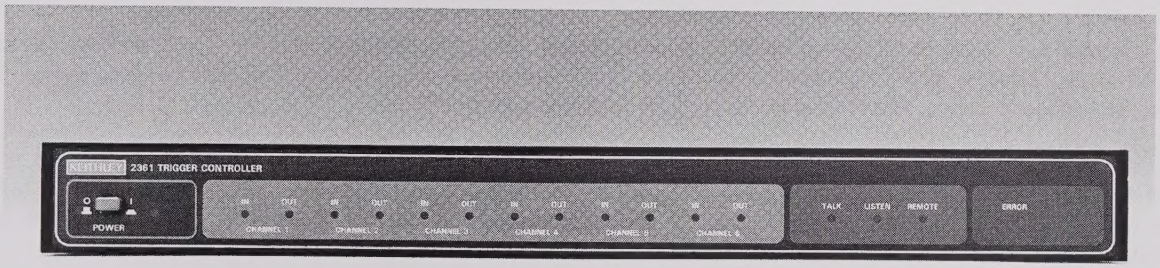

Contains Operating and Servicing Information

KEITHLEY

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Model 2361 Trigger Controller
Instruction Manual

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits (e.g., Keithley Models 175A, 199, 2000, 2001, 2002, and 2010) are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to mains.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Model 2361 Trigger Controller

OVERVIEW

TRIGGER CONTROLLER: Provides control of trigger pulses among up to six instruments. The manner in which the trigger signals are modified is programmable over the IEEE-488 bus. Includes 8-bit digital I/O port.

FUNCTION: Can be used to synchronize triggers from different instruments in a measurement system. A simple trigger programming language provides the flexibility to control instrument operation in a variety of ways.

TRIGGER I/O PROGRAM: Up to six input-output relations constitute the program which resides in internal memory. Non-volatile storage of up to three trigger I/O programs.

TRIGGER INPUT EXPRESSIONS: Specify what combinations of trigger inputs will cause a trigger output. Two operators are used in trigger input expressions:

\+ Same as the Boolean "OR" operator.

* "Cumulative AND" operator. The input expression evaluates true when the triggers on both sides of all operators have been received.

TRIGGER OUTPUT EXPRESSIONS: Specify what combination of trigger outputs will occur after its input expression has evaluated true.

SIGNALS

CONFIGURATION:

Six trigger inputs, TTL compatible.
Six trigger outputs, TTL compatible.
One 8-bit digital input port, TTL compatible.
One 8-bit digital output port, TTL compatible.

TRIGGER CHANNELS:

Input: May be programmed to detect rising or falling edges.
Output: Active low pulse, maximum pulse width 110µs.

DIGITAL I/O:

Input: May be programmed to detect level or edges (either rising or falling).
Output: Specified level appears on digital output lines.

IEEE-488 BUS IMPLEMENTATION

MULTILINE COMMANDS: DCL, SDC, UNT, UNL, SPE, SPD.

UNILINE COMMANDS: IFC, REN, EOI, SRQ, ATN.

INTERFACE FUNCTIONS: SH1, AH1, T6, TE0, L4, LE0, SR1, RL2, PP0, DC1, DT0, C0, E1.

SRQ OPTIONS: SRQ on any of the following events: Trigger input detected, digital input detected, ready for IEEE-488 command, error.

PROGRAMMABLE FUNCTIONS: Trigger I/O programming, trigger I/O program initialization, trigger I/O program storage and retrieval, trigger input edge polarity, trigger response enable/disable, trigger latch initialization, trigger output generation, digital output specification, digital input edge polarity, SRQ masking, IEEE-488 holdoff, IEEE-488 output terminator, system status readback, factory default reset.

IEEE-488 address is set manually from the rear panel.

EXECUTION SPEED

INPUT PULSE WIDTH: 50ns minimum, unlimited maximum.

CHANNEL SYNCHRONIZATION (typical): Output pulses are synchronized to within 5ns.

TRIGGER PROPAGATION DELAY (IEEE-488 inactive): 350µs maximum, 100µs typical (T0D0, only one trigger I/O relation evaluates true).

PULSE RECOGNITION RATE: 2kHz maximum at any trigger input.

RESPONSE TO IEEE-488 COMMAND:

Trigger Control Commands: 2.5ms maximum.
Trigger I/O Program: 25ms maximum.

GENERAL

CONNECTORS:

Trigger Input, Output: Six BNC connectors each on rear panel.
Digital I/O: 20 pin card edge.

ENVIRONMENT: **Operating:** 0°–50°C; 0–70% R.H.
Storage: –25°C to 65°C.

POWER: 90–125 or 180–250V AC (internal switch selectable); 50–60 Hz. 10VA max.

DIMENSIONS, WEIGHT: 425mm wide × 45mm high × 309mm deep (16¾ in. × 1¾ in. × 12 in.). Net weight 2.7 kg. (6.2 lbs.).

ACCESSORIES SUPPLIED:

7051-2 BNC Interconnect Cable, 0.6m (2 ft.)

Specifications subject to change without notice.

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Model 2361 Trigger Controller

1.1 INTRODUCTION

The Model 2361 controls the routing of TTL-compatible trigger signals among a maximum of six instruments. A simple trigger programming language is included to specify what combination of trigger inputs cause an output.

1.1.1 Shipment Contents

The following items are included with every Model 2361:

Description	Keithley Part No.
Line Cord	CO-19
Feet (4)	FE-24-1
Rack Ears (2)	2361-311
Screws (4), for rack ears	10-32×3/8PFHBLKOX
Screws (8), nylon	10-32×1/4PBHBLKNY
20-pin Digital I/O Connector	CS-444-2
20-pin Digital I/O Self-test Connector	2361-314
BNC Interconnect Cable (4)	7051-2

1.1.2 Optional Accessories

Model 7051 BNC Interconnect Cables — Model 7051 cables are used for making connections to trigger in and trigger out connections on the Model 2361 rear panel. The Model 7051-2 is a 50Ω BNC to BNC cable (RG-58C), which is 0.6m (2 ft.) long. The Models 7051-5 and 7051-10 are similar, but 5 feet and 10 feet in length respectively.

Model 7007 Shielded IEEE-488 Cables — A Model 7007 connects the Model 2361 to the IEEE-488 bus using shielded cables to reduce electromagnetic interference (EMI). The Model 7007-1 is one meter (3.3 ft.) long and has an EMI shielded IEEE-488 connector at each end. The Model 7007-2 cable is identical to the Model 7007-1, but is 2m (6.6 ft.) long.

1.2 FRONT PANEL INDICATORS

The Model 2361 front panel is shown in Figure 1.

Trigger Channel In/Out Indicators

Each of the six trigger channels has two LEDs on the front panel, IN and OUT. An IN LED will blink when a trigger is received on that channel; an OUT LED will blink when a trigger is sent to that channel.

If a channel is used in a "Cumulative AND" expression on the input side of a relation, the IN LED will remain lit until the expression evaluates true.

If a trigger is received on a channel that is not used in an input expression, the IN LED will turn on and remain lit until that channel is cleared.

IEEE-488 Status Indicators

The TALK, LISTEN, and REMOTE indicators show the present IEEE-488 status of the instrument. Each of these indicators is briefly described below.

TALK — This indicator is on when the instrument is in the talker active state. The unit is placed in this state by addressing it to talk. TALK is off when the unit is in the talker idle state.

LISTEN — This indicator is on when the Model 2361 is in the listener active state. LISTEN is off when the unit is in the listener idle state.

REMOTE — This indicator shows when the instrument is in the remote state. When REMOTE is turned off, the instrument is in the local state.

Error Indicator

The ERROR LED will light when one of the following error conditions occurs:

- Trigger test failed
- Digital I/O test failed
- ROM test failed
- RAM test failed
- Illegal device-dependent command option (IDDCO)
- Illegal device-dependent command (IDDC)

1.3 CONFIGURATION

The Model 2361 has one 8-position DIP switch (S102) accessible from the rear panel (see Figure 2 and Figure 3). This switch determines the unit's IEEE address, default trigger I/O program, and test mode. The switch is read only when the unit is powered on and should be set prior to applying power.

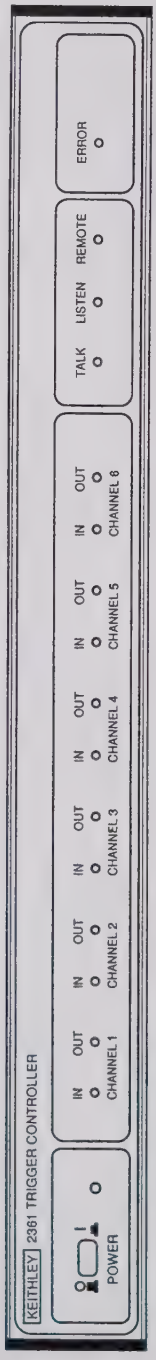
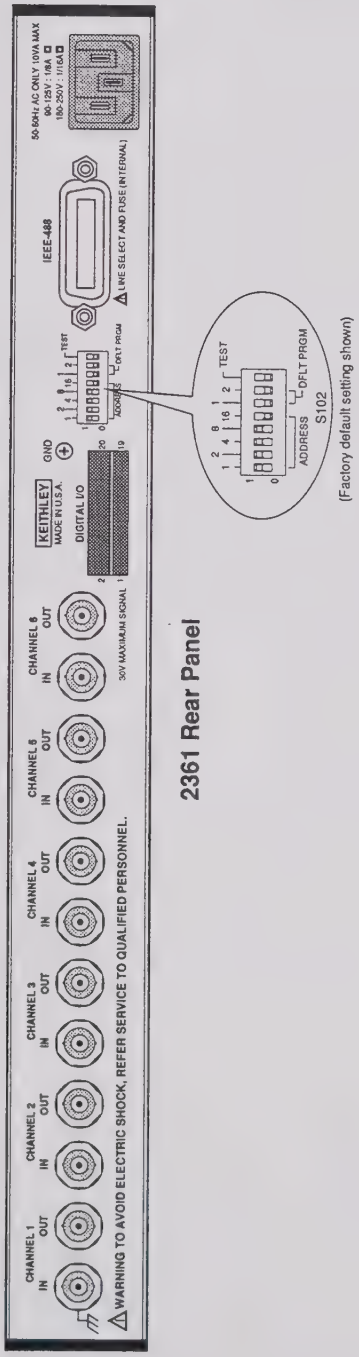


Figure 1. Model 2361 Front Panel



2361 Rear Panel

Figure 2. Model 2361 Rear Panel

The factory default settings of the switch are shown in Figure 3. To modify any of these defaults, turn the instrument off and change the switch setting using a small screwdriver.x

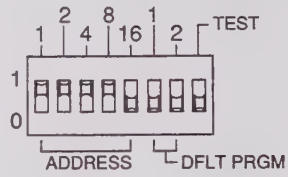


Figure 3. 2361 Rear Panel Dip Switch (S102)

IEEE-488 Address Selection

The IEEE-488 bus address is set by S102. The address can be set from 0 through 30 and is read only at power on. The address is selected by simple binary weighting with switch 1 being the least significant bit and switch 5 the most significant bit. The factory default address is 15.

Trigger I/O Program Selection

Up to three trigger I/O programs can be stored in EEPROM. The following switch settings of S102 determine the program that is loaded on power-up.

DFLT PRGM Switch

1	2	
0	0	
1	0	Program #1 (EEPROM)
0	1	Program #2 (EEPROM)
1	1	Program #3 (EEPROM)

Test Selection

The TEST position of S102 selects a power-up self-test that checks trigger and digital I/O signal paths (see power-up procedure).

1.4 CONNECTIONS

Trigger Channels

The Model 2361 has six trigger channels; each channel uses two BNC connectors; one for the input and one for the output. Trigger signals are connected with Model 7051-2 BNC cables.

The normal connection scheme has an external instrument's trigger out signal going to a CHANNEL IN connector on the Model 2361 rear panel. To complete the loop, a BNC cable is connected from a Model 2361 CHANNEL OUT to the instrument's trigger in. An example connection schematic is shown in Figure 4.

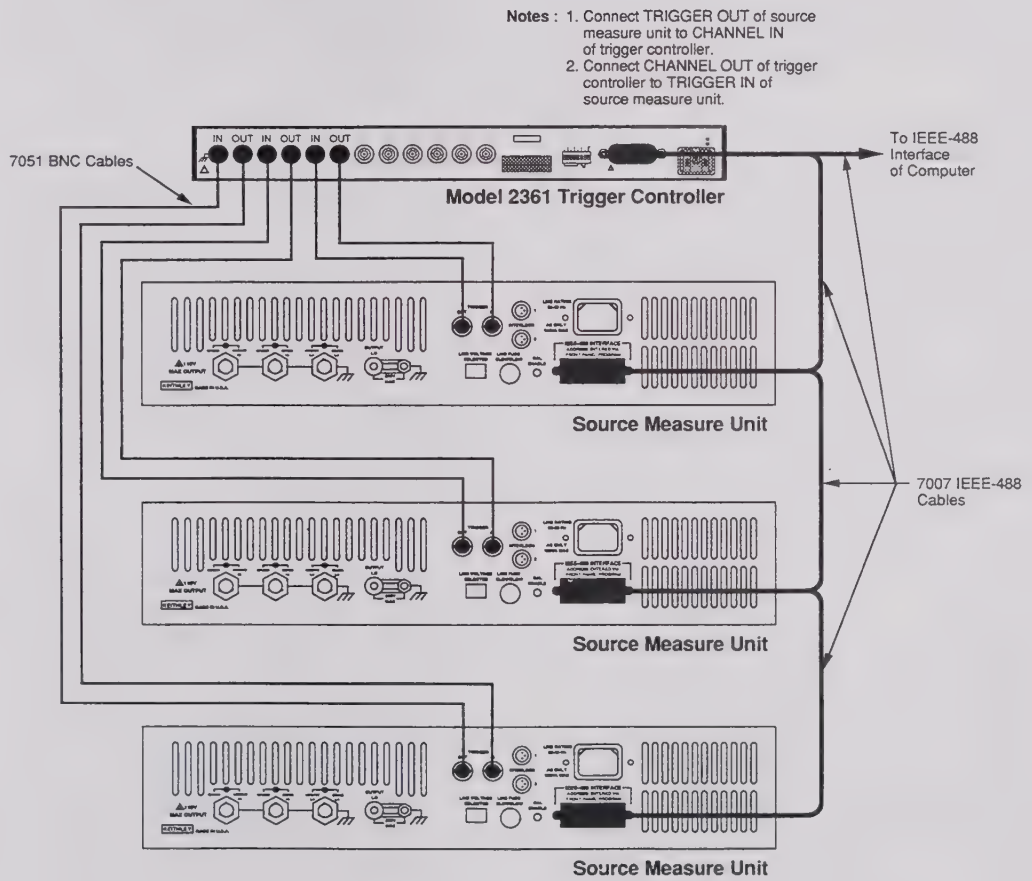

Notes : 1. Connect TRIGGER OUT of source measure unit to CHANNEL IN of trigger controller.
2. Connect CHANNEL OUT of trigger controller to TRIGGER IN of source measure unit.
IN OUT IN OUT IN OUT
7051 BNC Cables
To IEEE-488 Interface of Computer
Model 2361 Trigger Controller
Source Measure Unit
Source Measure Unit
Source Measure Unit
7007 IEEE-488 Cables

Figure 4. Multiple Unit Trigger Connections

Digital I/O

The DIGITAL I/O port located on the rear panel is shown in Figure 5. It is a 20-pin card-edge connector. Sixteen pins are used for the eight digital channels, with input pins located on the top row of the connector and output pins located on the bottom row. The eight digital channels are identified on the drawing. Also note that two pins are used to access +5V and two pins are used to access digital ground. The connector pinout is also provided by Table 1.

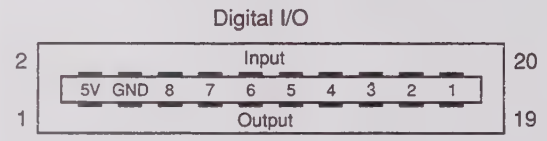


Figure 5. Digital I/O Connector

Table 1. Digital I/O Port Pinout

Pin	Signal	Pin	Signal
1	+5 volts	11	Digital Output 5
2	+5 volts	12	Digital Input 5
3	Digital Ground	13	Digital Output 4
4	Digital Ground	14	Digital Input 4
5	Digital Output 8	15	Digital Output 3
6	Digital Input 8	16	Digital Input 3
7	Digital Output 7	17	Digital Output 2
8	Digital Input 7	18	Digital Input 2
9	Digital Output 6	19	Digital Output 1
10	Digital Input 6	20	Digital Input 1

The Digital I/O connector will mate with the supplied 20-pin Digital I/O connector. This connector is equipped with solder lugs to accommodate cable connections.

In order to minimize susceptibility to electromagnetic interference (EMI) and radio frequency interference (RFI), use shielded wires for digital input and output lines. The shields should then be connected directly to the GND (ground) screw on the rear panel.

1.5 HARDWARE INSTALLATION

Included with the Model 2361 are accessories for rack or bench use. If rack mount installation is desired, install the two rack ears using the enclosed screws. These ears can be installed so either the front or rear of the unit faces the front of the rack fixture (see Figure 6).

NOTE

The front and rear rack mount holes may contain 10-32 × 1/4" nylon screws. Remove the four appropriate nylon screws and attach the rack ears using the four 10-32 × 3/8" screws.

WARNING

A potential shock hazard will exist if screws longer than those supplied (10-32 × 3/8") are used to attach the rack ears.

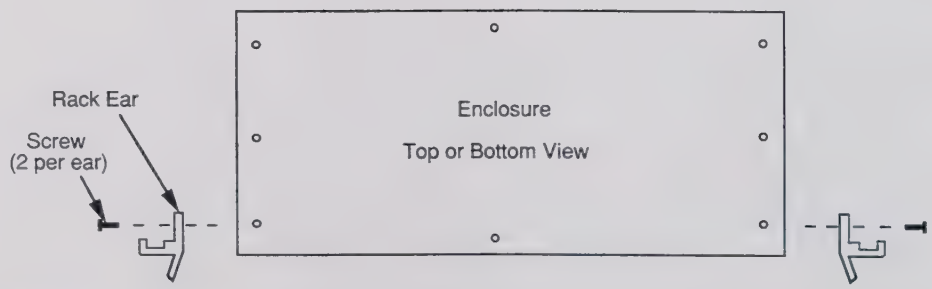


Figure 6. Rack Hardware Installation

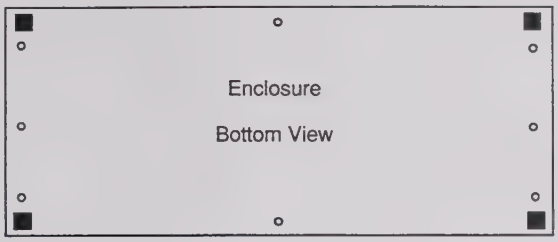


Figure 7. Feet Placement

If bench installation is desired, the rubber feet can be installed on the underside of the unit near each corner (see Figure 7).

1.6 POWER-UP PROCEDURE

1.6.1 Line Power

Use the following procedure to connect the Model 2361 to line power and power up the instrument.

1. Check that the instrument is set to correspond to the available line power. When the instrument leaves the factory, the internally selected line voltage is marked on the rear panel near the power jack. Ranges are 90-125V or 180-250V, 50-60Hz ac. If the line voltage setting of the instrument needs to be changed, a procedure is located in paragraph B.8.

CAUTION

Be sure that the line voltage agrees with the indicated range on the rear panel of the instrument. Failure to observe this precaution may result in instrument damage.

2. Connect the female end of the power cord to the ac receptacle on the rear panel of the instrument. Connect the other end of the cord to a grounded ac outlet.

WARNING

The Model 2361 is equipped with a 3-wire power cord that contains a separate ground wire and is designed to be used with grounded outlets. When proper connections are made, instrument chassis is connected to power line ground. Failure to use a grounded outlet may result in personal injury or death because of electric shock.

3. The instrument can be turned on by pressing in the front panel POWER switch. The switch will be at the innermost position (1) when the instrument is turned on.

1.6.2 Tests

The trigger controller has two power-up self tests. The start-up (and default) test proceeds as follows:

1. All front panel LEDs flash once when power is turned on.
2. The unit performs a ROM check. If this test fails, the LEDs corresponding to trigger channels 1, 2, and 3 (both in and out) will flash.
3. A RAM test is conducted by the instrument. Failure of this test causes LEDs corresponding to channels 4, 5, and 6 to flash.
4. The EEPROM is examined. The in and out LEDs of all six channels will flash if this test fails.

The self-test is optional and is initiated by setting DIP switch S102 to the TEST position (see Figure 3) before turning on the power. For normal operation, this switch should be set to "0". The Model 2361 will operate normally if the switch remains in the TEST position following completion of the self-test; however, the self-test will be executed if any power glitch occurs.

Connections

The self-test requires that all inputs (trigger and digital) be connected to their respective outputs as follows:

1. Using six BNC cables, connect IN to OUT for all six trigger channels.
2. Mate the supplied Digital I/O Self-test Connector to the DIGITAL I/O connector on the rear panel.

Self-Test

With S102 set for TEST, the self-test proceeds as follows:

1. The start-up test is performed.
2. Trigger channel rising edge test — A rising edge is generated at CHANNEL 1 OUT. When the edge is detected at CHANNEL 1 IN, both CHANNEL 1 LEDs are flashed. The remaining trigger channels are tested in order.
3. Trigger channel falling edge test — This test is the same as the previous step, but with a falling edge.
4. Digital I/O rising edge and high level test — A rising edge is generated at Digital Output 1 and detected at Digital Input 1. The Digital I/O channel 1 level line is then tested for a high level. When both edge and level are detected at Digital Input 1, the CHANNEL 1 IN LED flashes. The remaining Digital INs/OUTs are tested in order in a similar manner.
5. Digital I/O falling edge and low level test — This test is the same as the previous, but with a falling edge and a low level.

The order in which all signals are tested is given in Table 2

Table 2. Order of Channel Testing for Self-test

Signal Channel	LED in Self-test
Trigger 1	CHANNEL 1 IN and OUT
Trigger 2	CHANNEL 2 IN and OUT
Trigger 3	CHANNEL 3 IN and OUT
Trigger 4	CHANNEL 4 IN and OUT
Trigger 5	CHANNEL 5 IN and OUT
Trigger 6	CHANNEL 6 IN and OUT
Digital 1	CHANNEL 1 IN
Digital 2	CHANNEL 1 OUT
Digital 3	CHANNEL 2 IN
Digital 4	CHANNEL 2 OUT
Digital 5	CHANNEL 3 IN
Digital 6	CHANNEL 3 OUT
Digital 7	CHANNEL 4 IN
Digital 8	CHANNEL 4 OUT

1.7 IEEE-488 BUS PROGRAMMING

1.7.1 Trigger I/O Programs

The trigger I/O program provides the means for the Model 2361 Trigger Controller to determine when and where to send output triggers. Trigger I/O programs are sent to the trigger controller just like device-dependent commands.

A program consists of up to six trigger I/O relations, each of which relates specified inputs to specified outputs. Each relation consists of an input expression and an output expression separated by the greater than (>) character.

Trigger input expressions specify what combination of trigger inputs will cause a trigger output. Trigger output expressions specify what combination of trigger outputs will occur after the corresponding input expression has evaluated true.

Valid relations contain channel numbers (1-6) and operators, which specify output trigger conditions dependent upon the states of the input channels. The legal operators are as follows:

* Logical "AND" for inputs and outputs, cumulative for inputs (See Note 5.)
\+ Logical "OR", for inputs only
\> I/O separator, separates the input expression from the output expression
; Relation separator, delimits relation in a multiple relation command string

Examples

```
OUTPUT 715;"1>2X"          !If 1 triggered, trigger out 2.
OUTPUT 715;"1*2>1X"        !If 1 and 2 are triggered, trigger out 1.
OUTPUT 715;"1*2*3>1*6X"    !When inputs 1, 2 and 3 are triggered, trigger out 1 and 6.
OUTPUT 715;"1+2*3>4X"      !If 1 or (2 and 3) are triggered, trigger out 4.
```

```
OUTPUT 715;"1*2+3>4X"      !If (1 and 2) or 3 are
                             triggered, trigger out 4.
OUTPUT 715;"1>1;2>2;       !All channels act as a
3>3;4>4;5>5;6>6X"            throughport, i.e., when 1
                             is triggered, trigger out 1,
                             when 2 is triggered, trig-
                             ger out 2, etc.
OUTPUT 715;"6+1>3;         !If 6 or 1 is triggered, trig-
4>1*3X"                      ger out 3. Also, if 4 is trig-
                             gered, trigger out 1 and 3.
OUTPUT 715;"1>1*6U2;       !If 1 is triggered, trigger
2>2X"                        out1 and 6. Obtain the
                             present program. Then, if
                             2 is triggered, trigger out
                             channel 2.
OUTPUT 715;"1*2*3>1*2*3X" !If 1 and 2 and 3 are
                             triggered, trigger out 1
                             and 2 and 3.
```

Notes

1. The maximum number of characters in any relation string is 46. More characters results in an error.
2. Inclusion of a trigger I/O program in a IEEE-488 command string will overwrite any previously defined program upon receipt of the next X command.
3. Each input channel may be used in only one of the input expressions in the program.
4. A program string must contain no more than six relations. This is a direct result of Note 3, since each of the six input channels may be used in only one relation.
5. Each output channel may be used in any number of the output expressions in the program.
6. Any output channels ANDed together in an output expression will produce output pulses simultaneously when the input expression evaluates true. However, if any input channels are ANDed together, the input pulses received by the individual channels are latched and held, one by one, until the input expression evaluates true. Only then are the latches cleared and the outputs produced.
7. All * operators are evaluated first, from left to right. All + operators are evaluated second, from left to right.

Examples of Illegal Relations

```
OUTPUT 715;"1>1;1>2X"      ! Input channel 1 is used
                             twice.
OUTPUT 715;"1>2+3X"        ! An OR operator appears
                             on the output side of the
                             relation.
```

Note: An illegal relation generates an IDDCO error and turns on the front panel "ERROR" indicator.

1.7.2 Device-dependent Commands

The program instructions covered in this section use examples written with Hewlett Packard BASIC version 4.0. This language was chosen because of its versatility in controlling the IEEE-488 bus.

Order of Command Execution

Device-dependent commands are not necessarily executed in the order they are received. Rather, the instrument always executes them in a specific order, as summarized in Table 3

If you wish to force a particular order of execution, simply include the execute (X) character after each command in the string. For example, the following string would be executed in the order received:

L1XS2X

Table 3. Order of Command Execution

Order	Command	Description
1	Z	Clear programs from EEPROM
2	C	Clear present program
3	program	Trigger I/O program
4	W	Delay
5	E	Enable/disable trigger response
6	F	Detect trigger input on falling edge
7	R	Detect trigger input on rising edge
8	S	Store program in EEPROM
9	K	Bus hold-off
10	L	Load program from ROM or EEPROM
11	M	SRQ mask format
12	O	Digital I/O
13	D	Digital input change mask
14	I	Clear trigger inputs
15	T	Trigger input change mask
16	U	Status
17	Y	Terminator
18	P	Immediate mode pulse
19	H	Detect digital input on rising edge
20	B	Detect digital input on falling edge
21	J	Restore factory default settings

This forced sequence will load Program 1 from EEPROM and then store it as Program 2 in EEPROM. If the X after the L1 command is omitted (L1S2X), the S2 command will be executed first. In that case, the current active program will be stored as Program 2 in EEPROM, and then Program 1 will be loaded as the active program.

Device-dependent Command Summary

All Model 2361 device-dependent commands are summarized in Table 4.

Table 4. Device-dependent Command Summary

Command	Code	Description
Detect Digital Input on Falling Edge	Bn	Set digital input channels to detect an input on its falling edge (0-8).
Clear Present Program	C0	Clear present program from memory.
Digital Input Change Mask	Dn	Determine which digital input channels will set DIGCHNG bit in serial poll byte (0-255).
Trigger Response	En	Enable (E0) or disable (E1) input trigger channels.
Detect Trigger Input on Falling Edge	Fn	Detect an input trigger on its falling edge (0-6).
Detect Digital Input on Rising Edge	Hn	Set a digital input to detect an input on its rising edge (0-8).
Clear Trigger Inputs	In	Initialize a trigger input latch(es) to the non-triggered state (0-6).
Restore Factory Defaults	J0	Restore factory default settings.
Bus Hold-off	Kn	Enable (K0) or disable (K1) bus hold-off on X.
Load Program from ROM or EEPROM	Ln	Recall a previously stored program (0-3).
SRQ Mask Format	Mn	Program which conditions generate an SRQ (service request). M0 = SRQ disabled M1 = Digital input change M2 = Trigger input change M16 = Ready for input M32 = Error
Digital I/O	On	Assert the digital output lines (0-255).
Immediate Mode Pulse	Pm	Send a pulse to specified trigger output(s) (0-6).
Detect Trigger Input on Rising Edge	Rn	Set trigger input channel to detect on rising edge (0-6).
Store Program in EEPROM	Sn	Store present program in EEPROM (1-3).
Trigger Input Change Mask	Tn	Determine which trigger input channels will set the TRGCHNG bit in serial poll byte (0-63).
Status	Un	Obtain instrument status and configuration information. U0 = Send machine status word U1 = Send error status word (0-255) U2 = Send present active program U3 = Send latched trigger input state (0-63) U4 = Send latched digital input state and clear latches U5 = Send DIP switch setting (0-255) U6 = Send trigger and digital input edge detection polarities U7 = Send firmware revision level
Delay	Wn	Delay in 500µsec increments between input expression evaluating true and sending output pulse (0-255).
Execute	X	Execute command string.
Terminator	Yn	Select ASCII terminator sequence for strings. Y1 = CR LF Y2 = LF CR Y3 = CR Y4 = LF
Clear All Programs	Z0	Clear all programs from EEPROM.

B Detect Digital Input On Falling Edge

Purpose

To set specified digital input(s) to detect a trigger on its falling edge.

Format

Bn

Parameters

n = 0; Set all digital inputs to detect triggers on falling edges.
n = 1 to 8; The digital input(s) "n" that is to detect an input on its falling edge.

Default

Upon power-up, or after a DCL or SDC command, all digital inputs are set to detect input triggers on falling edges (B0).

Description

The B command sets a digital input line(s) (via DIGITAL I/O port) to detect an incoming trigger on its falling edge.

Programming Note

1. This command, along with the H command, also controls the polarity of the edge which triggers an SRQ on a digital input change for those inputs that are set to generate an SRQ in the DIGCHNG mask (see M command).
2. Any time a B or H command is used, the corresponding digital input channel latch is cleared.

Programming Examples

```
OUTPUT 715;"B1X"          ! Detect falling edge of trigger on input #1.
OUTPUT 715;"B2XB3X"       ! Detect falling edge of triggers on inputs #2 and #3.
```

C Clear Present Program

Purpose

To clear the present program from memory.

Format

C0

Parameters

C0 Clear present program from memory

Description

The C command clears the active program from the trigger controller's RAM. Programs stored in EEPROM are not affected.

Programming Notes

1. The C command does not clear either the digital or the or trigger input latches. For the latches to be cleared, the I command must be used.
2. The zero in the command string may be omitted.

Programming Examples

```
OUTPUT 715;"C0X"                ! Clear present program
```

D Digital Input Change Mask

Purpose

To determine which digital input channel(s) will set the DIGCHNG bit in the serial poll byte when the appropriate trigger edge occurs.

Format

Dn

Parameters

n = 0 to 255; An integer value that is the decimal weighted sum of the selected bits in the digital input change mask.

Default

Upon power-up, or after receiving a DCL or SDC command, the digital input change mask will default to D0.

Description

The digital input change mask determines which digital input channels (via DIGITAL I/O port) will cause the DIGCHNG bit, located in the serial poll byte, to be set when the appropriate edge (rising or falling as determined by the H and B commands) is detected.

The bits of this 8-bit mask (see Figure 8) represent the eight digital input channels. The MSB (B7) represents digital input #8, and the LSB (B0) represents digital input #1.

Bit Position	B7	B6	B5	B4	B3	B2	B1	B0
Decimal Weighting	128	64	32	16	8	4	2	1
Digital Input Channel	8	7	6	5	4	3	2	1

Figure 8. Digital Input Change Mask

The desired channels are selected by simply setting the corresponding bit in the mask. To program the mask, the decimal weighted sum of the set bits are sent with the D command. For example, to set the mask for digital input channels 8 and 1, send D129X over the bus.

Then, when an edge is latched at any of the specified channels, DIGCHNG in the serial poll byte (see M command) is set. The DIGCHNG bit is cleared when all digital input latches are cleared by a U4 status request.

Programming Examples

```
10 REMOTE 715
20 OUTPUT 715;"D1X"          ! Set DIGCHNG on digital
                               channel 1 state change
30 OUTPUT 715;"M1X"          ! Set to SRQ on DIGCHNG
40 S=SPOLL(715)              ! Serial poll the 2361
50 IF NOT BIT(S,6) THEN 40   ! Wait for SRQ
60 PRINT "Change in state
   occurred at ch. 1"
70 END
```

E Trigger Response

Purpose

To enable/disable the input trigger channels.

Format

En

Parameters

E0 Enable input triggers.
E1 Disable input triggers.

Default

Upon power-up, or after receiving a DCL or SDC command, the instrument triggers are enabled (E0).

Description

The E command determines whether or not the input trigger channels will be examined. If the inputs are enabled, the outputs will be determined by the current active program. If the inputs are disabled, all input triggers will be ignored.

Programming Note

1. Trigger channel input latches can still be set by an incident trigger with the input triggers disabled. The relations of set triggers will be executed when the E0 command is sent over the bus.
2. Any time a new trigger program is sent on the IEEE-488 bus, the trigger response defaults to the enabled condition (E0).
3. A trigger program can be installed with trigger response disabled by loading it from EEPROM using the L command if it was stored with trigger response disabled (E1).

Programming Examples

```
10 REMOTE 715
20 OUTPUT 715;"I0X"          ! Clear input latches
30 OUTPUT 715;"1*2>3X"       ! Trigger out 3 if inputs 1 and 2 are triggered
40 OUTPUT 715;"E1X"          ! Disable input triggers
50 END
```

F Detect Trigger Input On Falling Edge

Purpose

To detect an input trigger on its falling edge.

Format

Fn

Parameters

n = 0; Set all trigger channels to detect an input on its falling edge
n = 1 to 6; Trigger channel number to be triggered on a falling edge input.

Default

All trigger inputs default to a falling edge trigger status (F0) on power-up, or a DCL or SDC command.

Description

With the F command, you can specify which, if any, input trigger channel(s) will latch an input on its falling edge.

Programming Note

1. This command, along with the R command, also controls the polarity of the edge that triggers an SRQ on trigger input for those channels that are set to generate an SRQ in the TRGCHNG mask.
2. Any time an F or R command is used, the corresponding trigger input channel latch is cleared.

Programming Examples

```
10 REMOTE 715
20 OUTPUT 715;"F1XF2X"          ! Falling edge detection on 1 and 2
30 OUTPUT 715;"1+2>3X"          ! If 1 or 2 is triggered, trigger out 3
40 END
```

H Detect Digital Input On Rising Edge

Purpose

To set a digital input to detect an input on its rising edge.

Format

Hn

Parameters

n = 0; Set all channels to detect a trigger on its rising edge.
n = 1 to 8; Digital channel which is to detect an input trigger on its rising edge.

Default

On power-up, or after receiving a DCL or SDC command, all digital input lines default to a falling edge detection state (B0).

Description

The H command sets a digital input line(s) to detect an incoming trigger on its rising edge.

Programming Note

1. This command, along with the B command, also controls the polarity of the edge that triggers an SRQ on a digital input change for channels that are set for an SRQ in the DIGCHNG mask (see M command).
2. Any time a B or H command is used, the corresponding digital input channel latch is cleared.

Programming Examples

```
OUTPUT 715;"H1XH2X"          ! Rising edge detection on 1 and 2
```

I Clear Trigger Inputs

Purpose

To initialize a trigger input latch(es) to the non-triggered state.

Format

In

Parameters

n = 0; Clear all trigger latches
n = 1 to 6; Trigger channel latch to be cleared

Default

All latches are cleared (I0) on power-up, or after receiving a DCL or SDC command.

Description

The I command initializes the specified trigger input latch to a non-triggered state, i.e., sets the desired latch output to a logical "0" state.

Programming Notes

For the command string I0X (clear all the trigger latches), the "0" parameter may be omitted. Thus, instead of sending I0X over the bus, simply send IX.

Programming Examples

```
10 REMOTE 715
20 OUTPUT 715;"R1XR2X"          ! Detect triggers 1 and 2 on rising edge
30 OUTPUT 715;"1*2>3I0X"        ! Trigger out 3 if inputs 1 and
40 END                            2 are triggered, and clear all latches
```

J Restore Factory Defaults

Purpose

To return the instrument to factory default settings.

Format

J0

Parameter

J0 Return to factory default conditions.

Description

The J0 command sets all device-dependent commands to factory default status (see U0 status word), clears the present active program, clears all latches, and loads EEPROM with the following default programs:

Program	Program Relations
1	1>1; 2>2; 3>3; 4>4; 5>5; 6>6
2	1*2>1*2; 3*4>3*4; 5*6>5*6
3	1*2*3>1*2*3; 4*5*6>4*5*6

With the three default programs stored in EEPROM, any one can be used as the active program by loading it using the L command. L1 loads program 1, L2 loads program 2 and L3 loads program 3. See L command for more details.

Programming Notes

1. The "0" in the command string may be omitted. Send JX to return the instrument to the factory defaults.
2. The J0 command takes approximately 30 seconds to complete.

Programming Examples

```
OUTPUT 715;"J0X"                ! Restore factory defaults
```

K Bus Hold-Off

Purpose To enable or disable bus hold-off on X.

Format **Kn**

Parameters
K0 Enables bus hold-off on X.
K1 Disables bus hold-off on X.

Default The default on power-up, or after a DCL or SDC command is K0.

Description Bus hold-off allows the instrument to temporarily hold up bus operation via the NRFD line when it receives the X character until all commands are processed. The advantage of using bus hold-off is that commands are not missed while the instrument is processing previously received commands.

Programming Examples

```
OUTPUT 715;"K0X"          ! Enable bus holdoff
```

L Load Program From EEPROM

Purpose To load a previously stored program from EEPROM.

Format **Ln**

Parameters

L0 Clear current program (no active program).
L1 Load Program 1 from EEPROM.
L2 Load Program 2 from EEPROM.
L3 Load Program 3 from EEPROM.

Description

The L1 through L3 commands allow the user to load a program from EEPROM and make it the active program. The three programs stored in EEPROM may be programs defined and saved by the user (see S command), or may be factory default programs (see J command).

The L0 command clears the program that was currently active. With no active program, the trigger controller ignores external trigger inputs.

When the unit is powered up, one of the three programs can be automatically loaded from EEPROM. This is accomplished by setting the rear panel DFLT PRGM switches (see Figure C-3) to the proper configuration. The switch settings correspond to the following programs:

DFLT PRGM Switch

1	2	
0	0	No active program
1	0	Program 1
0	1	Program 2
1	1	Program 3

Programming Notes The trigger input edge polarity status and the trigger response status are loaded along with the trigger I/O program.

Programming Examples

```
OUTPUT 715;"L1X"          ! Load program 1
```

M SRQ Mask and Serial Poll Byte Format

Purpose To program which conditions generate an SRQ (service request).

Format **Mn**

Parameters n = Sum of bits in the SRQ mask

M0 Disable SRQ
M1 Digital Input Change
M2 Trigger Input Change
M16 Ready
M32 Error

Default The instrument defaults to an M0 state on power-up, or after receiving a DCL or SDC command.

Description **SRQ Mask** — The Model 2361 uses an internal mask to determine which conditions will cause an SRQ (service request) to be generated. Figure 9 shows the general format of this mask, which is made up of eight bits.

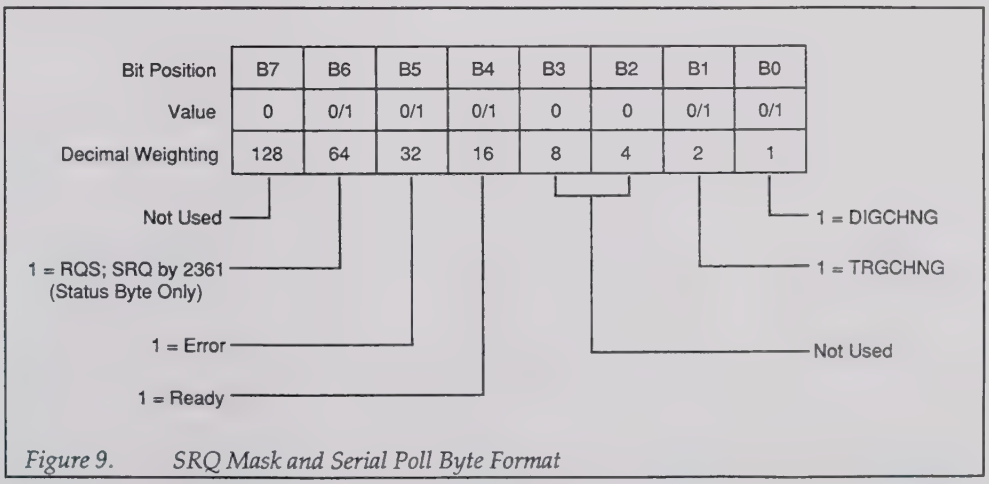


Figure 9. SRQ Mask and Serial Poll Byte Format

SRQ can be programmed by sending the ASCII letter "M" followed by a decimal number to set the appropriate bit in the SRQ mask. Decimal values for the various bits are included in Figure 9 and also listed in the "Parameters" section. Note that the instrument may be programmed for more than one set of conditions simultaneously. To do so, simply add up the decimal bit values for the required SRQ conditions. For example, to enable SRQ under trigger input change and error conditions, send M34. To disable SRQ, send M0X. This command clears all bits in the SRQ mask.

Available SRQ conditions include:

- Digital Input Change (M1) — Program for an SRQ on a digital input change.
- Trigger Input Change (M2) — Program for an SRQ on a trigger input change.
- Ready (M16) — Program for SRQ when ready to accept additional commands.
- Error (M32) — Program for SRQ when an error condition has occurred.

Serial Poll Byte Format — The serial poll byte contains information relating to data and error conditions within the instrument. The general format of this status byte is shown in Figure C-9. Note that the various bits correspond to the bits in the SRQ mask as described above.

The bits in the serial poll byte have the following meaning:

Bit 0 DIGCHNG (Digital Input Change) — Set when the appropriate edge has been detected at a digital input channel, and that the bit in the digital input change mask corresponding to that channel has been set (see D command – Digital Input Change Mask).

Bit 1 TRGCHNG (Trigger Input Change) — Set when the appropriate edge has been detected at a trigger input channel, and that the bit in the trigger input change mask corresponding to that channel has been set (see T command – Trigger Input Change Mask).

Bit 4 Ready — Set when the instrument has processed all previously received commands and is ready to accept additional commands. Cleared while the instrument is processing commands.

Bit 5 Error — Set when one of the following error conditions has occurred:

1. Power-up test (RAM/ROM) failure
2. Operational self test (Digital I/O, Trigger I/O) failure
3. Illegal device-dependent command (IDDC)
4. Illegal device-dependent command option (IDDCO)

This bit is cleared when the U1 status word is read to determine the type of error (see U command – Status).

Bit 6 RQS (Request for service) — Set if the instrument asserted SRQ. Cleared when the instrument is serial polled.

Programming Note

If SRQ is disabled (M0), then the serial poll byte reflects the real-time state of the instrument:

- The TRGCHNG and DIGCHNG bits are reset by resetting the appropriate latches, either with the I command or under control of the active trigger program.
- The READY bit is reset whenever the unit is ready for another IEEE-488 byte.
- The Error bit is reset by a U1 status request.

Programming Examples

```
10  DIM Error$ [50]
20  REMOTE 715
30  OUTPUT 715;"M32X"          ! Program for SRQ on error
40  OUTPUT 715;"E2X"           ! Program illegal option
50  S=SPOLL(715)               ! Serial poll the 2361
60  IF NOT BIT(S,6) THEN 50    ! Wait for SRQ
70  PRINT"B7 B6 B5 B4 B3       ! Label bit positions
    B2 B1 B0"
80  FOR I=7 TO 0 STEP – 1      ! Loop 8 times
90  PRINT BIT(S,I)             ! Display the bit positions
100 NEXT I
110 PRINT
120 OUTPUT 715;"U1X"           ! Get status byte
130 ENTER 715;Error$
140 PRINT Error$               ! Display status byte
150 END
```

O Digital I/O

Purpose To assert the digital output lines high.

Format **On**

Parameters n = 0 to 255; Sum of bits in digital output byte.

Default Upon power-up, or after receiving a DCL or SDC command, all eight digital output lines are at 0V (O0).

Description The O command specifies which of the eight digital output lines will be asserted high by using a binary output byte representation (see Figure 10). Each of the eight digital output channels are assigned a bit. The least significant bit represents output channel 1, while the most significant bit represents output channel 8. An output channel is asserted high by sending the decimal equivalent of the appropriate bit position with the O command. For example, to assert digital output channel 3 high, send O4X. To assert multiple channels high, add up the decimal equivalents of the appropriate bit positions. For example, to assert output channels 5 and 7, send O80X.

Bit Position	B7	B6	B5	B4	B3	B2	B1	B0
Decimal Weighting	128	64	32	16	8	4	2	1
Digital Output Channel	8	7	6	5	4	3	2	1

Figure 10. Digital Output Byte

Programming Notes The digital output pattern is a level output only. Any bit pattern specified with the O command will output a steady state until the next O command.

Programming Examples

```
10 REMOTE 715
20 OUTPUT 715;"T63X"      ! Set TRGCHNG on any trigger state change
30 OUTPUT 715;"M2X"       ! SRQ on TRGCHNG
40 OUTPUT 715;"1>1"       ! If 1 triggered, trigger out 1
50 S=SPOLL(715)           ! Serial poll the 2361
60 IF NOT BIT(S,6) THEN 50 ! Wait for SRQ
70 OUTPUT 715;"O1X"       ! Set digital output 1 high on a trigger state change
80 END
```

P Immediate Mode Pulse

Purpose

To send an immediate pulse to a specified output(s).

Format

Pn

Parameters

n = Any valid expression specifying the desired trigger output channel(s).

Description

The P command sends an immediate trigger pulse to the specified output channel or channels. The channels are specified in the output expression following the P command. The output expression can simply be a single decimal digit 1 to 8 that corresponds to the specified channel. For example, to send a trigger pulse to output channel 6, send P6X.

To send a trigger pulse to multiple channels use the "*" operator as shown in the following example to send a trigger pulse to output channels 3 and 4:

P3*4X

The specifications of the output trigger pulse are shown in Figure 11.

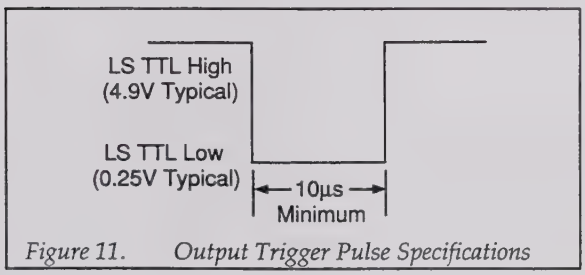


Figure 11. Output Trigger Pulse Specifications

Programming Notes

The P command does not affect the active trigger I/O program. It is an immediate mode output only.

Programming Examples

```
OUTPUT 715; "P1X"          ! Immediate trigger 1
OUTPUT 715; "P2*3"         ! Immediate trigger 2 and 3
```

R Detect Trigger Input on Rising Edge

Purpose

To set a trigger input channel to detect on its rising edge.

Format

Rn

Parameters

n = 0; Set all trigger input channels to detect an input trigger on its rising edge.
n = 1 to 6; Set the specified trigger input channel to detect an input trigger on its rising edge.

Default

All trigger input channels default to a falling edge trigger state (F0) upon power-up, or after receiving a DCL or SDC command.

Description

The R command allows the user to program an input trigger channel to latch an input on its rising edge.

Programming Note

1. This command, along with the F command, also controls the polarity of the edge which triggers an SRQ for those channels which are set to generate an SRQ using the TRGCHNG mask (see T and M commands).
2. Any time an F or R command is used, the corresponding trigger input channel latch is cleared.

Programming Examples

```
10 OUTPUT 715;"R1X"          ! Detect 1 on rising edge
20 OUTPUT 715;"R2X"          ! Detect 2 on rising edge
30 OUTPUT 715;"1+2>3"        ! If 1 or 2 is triggered, trigger out 3
40 END
```

S Store Program in EEPROM

Purpose

To store the current (active) program in EEPROM.

Format

Sn

Parameters

S1 Store program in memory as Program 1.
S2 Store program in memory as Program 2.
S3 Store program in memory as Program 3.

Description

The S command stores the currently active user program (which may be user defined) into EEPROM. Up to three programs can be stored and later recalled using the L command.

Programming Note

1. One of the three stored programs may be loaded from EEPROM when the instrument is powered up. The particular program (Program 1, 2 or 3) is specified by setting DIP switches on rear panel (see L command).
2. The trigger input edge polarity status and the trigger response status are stored along with the program.
3. If it is desired to store a user defined program with the trigger response disabled (E1), then the E1 command must be sent after the program is created. When a user defined program is created, trigger response is enabled (E0).

Programming Examples

```
10 REMOTE 715
20 OUTPUT 715;"R1X"          ! Detect inputs 1 and 2 on
30 OUTPUT 715;"R2X"            rising edge input
40 OUTPUT 715;"1*2>3X"       ! If 1 and 2 are triggered, trigger out on 3
50 OUTPUT 715;"S1X"          ! Store as program 1
60 END
```

T Trigger Input Change Mask

Purpose

To determine which trigger input channels will set the TRGCHNG bit in the serial poll byte when they receive a trigger.

Format

Tn

Parameters

n = 0 to 63; An integer value that is the decimal weighted sum of the selected bits in the trigger input change mask.

Default

Upon power-up, or after receiving a DCL or SDC command, the digital input change mask will default to T0.

Description

The digital input change mask determines which trigger input channels will cause the TRGCHNG bit, located in the serial poll byte, to be set when an input trigger is received.

Bits 0 through 5 of this mask (see Figure 12) represent the six trigger input channels. The MSB (B5) represents trigger input #6, and the LSB (B0) represents trigger input #1.

Bit Position	B7	B6	B5	B4	B3	B2	B1	B0
Decimal Weighting	128	64	32	16	8	4	2	1
Trigger Input Channel	-	-	6	5	4	3	2	1

Figure 12. Trigger Input Change Mask

The desired channels are selected by simply selecting the corresponding bit in the mask. To program the mask, the decimal weighted sum of the selected bits are sent with the T command. For example, to set the mask for trigger input channels 6 and 1, send T33X over the bus.

Then, when a trigger is received at the specified channels, TRGCHNG in the serial poll byte (see M command) is set.

Programming Examples

```
10 REMOTE 715
20 OUTPUT 715;"T1X"          ! Set TRGCHNG bit on channel 1 state change
30 OUTPUT 715;"1>2X"         ! If 1 triggered, trigger out 2
40 OUTPUT 715;"M2X"          ! Set to SRQ on TRGCHNG
50 S=SPOLL(715)              ! Serial poll the 2361
60 IF NOT BIT(S,6) THEN 50   ! Wait for SRQ
70 PRINT "Change in state
   occurred at ch. 1"
80 END
```

U Status

Purpose To obtain instrument status and configuration information.

Format **Un**

Parameters

U0 Send machine status word.
U1 Send error status word (0-255).
U2 Send present active program.
U3 Send latched trigger input state (0-63).
U4 Send latched digital input state and clear latches.
U5 Send DIP switch setting (0-255).
U6 Send trigger and digital input edge detection polarities.
U7 Send firmware revision level.

Description

By sending the proper U command and then addressing the instrument to talk as with normal data, you can obtain information on machine status, error conditions and other data. The information is transmitted only once for each U command.

U0 Send Machine Status Word

The U0 command lists the current modes programmed by the device-dependent commands. All returned values correspond to the last receivedvalues. On power-up, or after a DCL or SDC command is sent over the bus, the instrument will return to the following default conditions:

B0D000E1F0H0I0K0L0M00O000R0S0T00W000Y0

U1 Send Error Status Byte

The U1 command permits access to the trigger controller's error byte. The error byte is a decimal number representing binary positions (see Figure 13) that provides information about the machine's error status. For example, if the RAM and ROM tests failed, reading the U1 status byte will send the decimal value 12 (B2 and B3 set) to the computer.

An error condition will set the error bit in the SRQ serial poll status byte. If desired, the instrument can be programmed to generate an SRQ if an error condition occurs. Reading the U1 error status byte clears the error bit in the serial poll status byte (see M command).

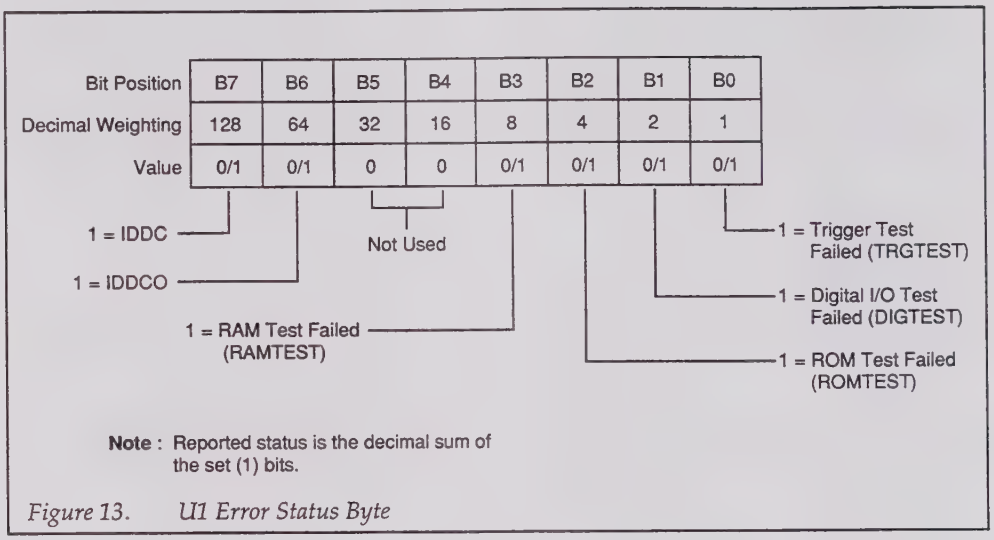

Bit Position
Decimal Weighting
Value
B7 B6 B5 B4 B3 B2 B1 B0
128 64 32 16 8 4 2 1
0/1 0/1 0 0 0/1 0/1 0/1 0/1
1 = IDDC
1 = IDDCO
Not Used
1 = RAM Test Failed (RAMTEST)
1 = Trigger Test Failed (TRGTEST)
1 = Digital I/O Test Failed (DIGTEST)
1 = ROM Test Failed (ROMTEST)
Note : Reported status is the decimal sum of the set (1) bits.

Figure 13. U1 Error Status Byte

U2 Send Present Active Program

The U2 command allows the user to obtain the active program relation(s) from the trigger controller.

U3 Send Latched Trigger Input State

The U3 command is used to determine the current state of the input trigger channel latches. The argument is the decimal sum of the set bits in the binary byte which represents the six trigger inputs (see Figure 14).

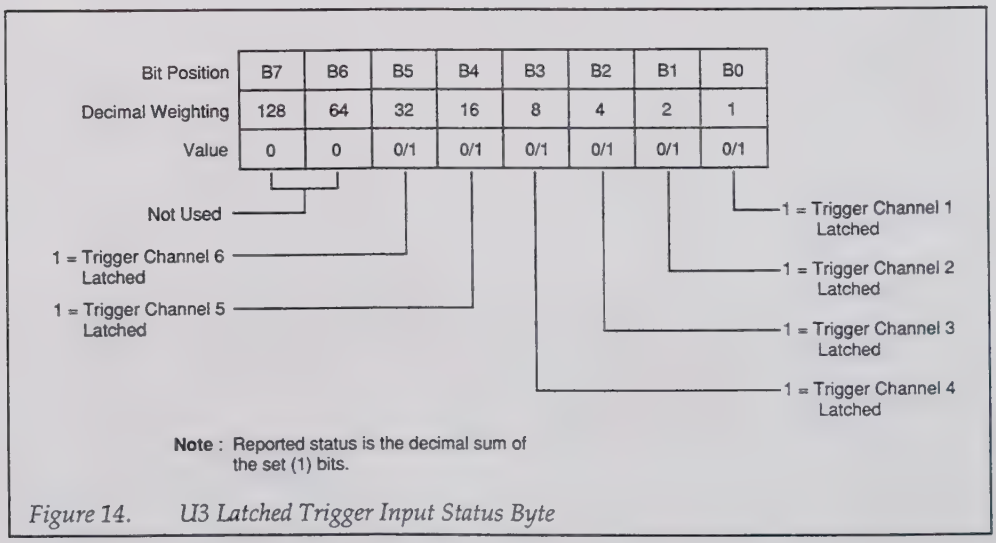

Bit Position
Decimal Weighting
Value
B7 B6 B5 B4 B3 B2 B1 B0
128 64 32 16 8 4 2 1
0 0 0/1 0/1 0/1 0/1 0/1 0/1
Not Used
1 = Trigger Channel 6 Latched
1 = Trigger Channel 5 Latched
1 = Trigger Channel 1 Latched
1 = Trigger Channel 2 Latched
1 = Trigger Channel 3 Latched
1 = Trigger Channel 4 Latched
Note : Reported status is the decimal sum of the set (1) bits.

Figure 14. U3 Latched Trigger Input Status Byte

U4 Send Latched Digital Input State and Clear

The U4 command is used to determine the current state of the digital input channel latches. The argument is the decimal sum of the set bits in the binary byte which represents the eight digital inputs (see Figure 15). Any set bit represents a channel that has detected an edge (trigger) of the polarity specified with the B or H command. When the U4 status is read, the latches are cleared.

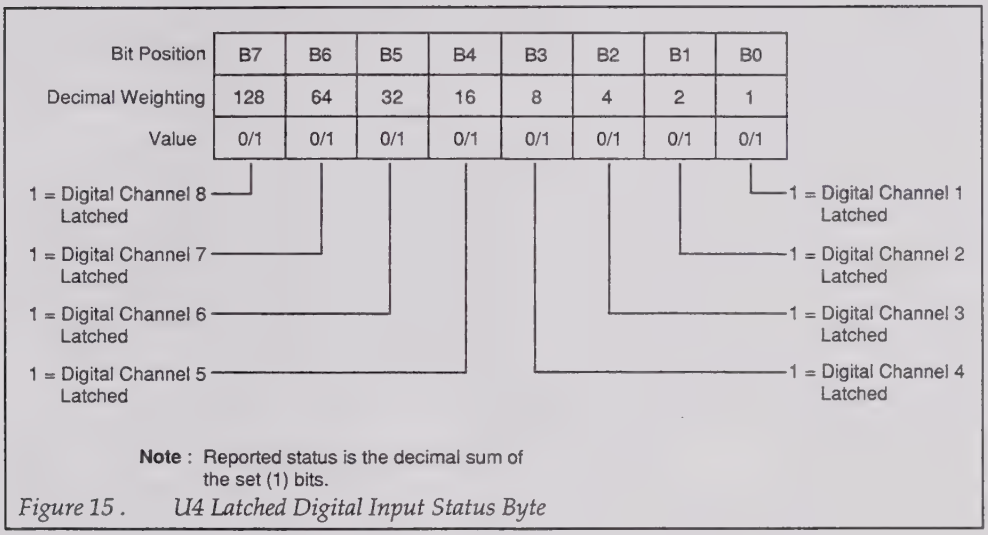


Figure 15 . U4 Latched Digital Input Status Byte

U5 Send DIP Switch Setting

The U5 command is used to read the rear panel DIP switch setting. The decimal value (0-255) represents the switch positions as shown in Figure 16.

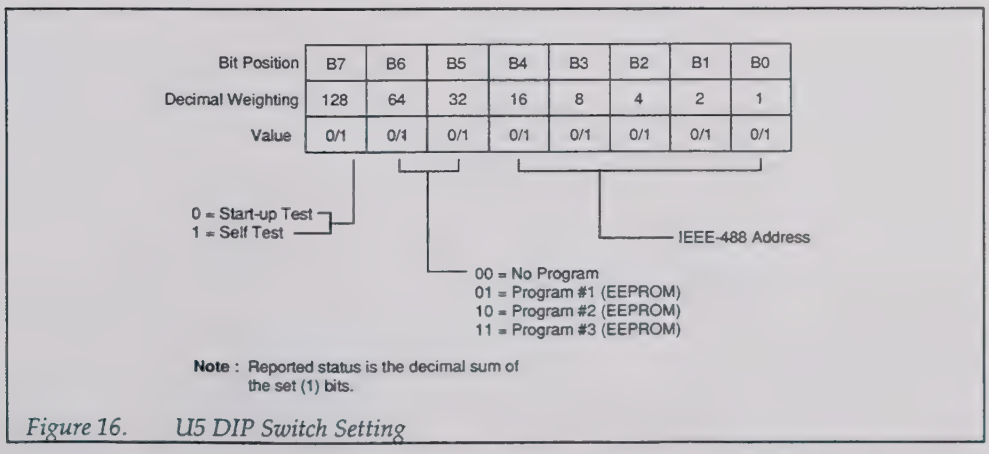


Figure 16. U5 DIP Switch Setting

U6 Send Trigger and Digital Input Rising Edge Detection Status

The U6 command is used to determine which trigger and digital channels are programmed to detect rising-edge input. The U6 status word is sent in the following form:

TmmDnnn

where; mm = 00 to 63; Decimal value of set bits in a binary byte that represents trigger input channels that were programmed for detection on rising edges using the R command (see Figure 17).

nnn = 000 to 255; Decimal value of set bits in a binary byte that represents digital input channels that were programmed for detection on rising edges using the H command (see Figure 18).

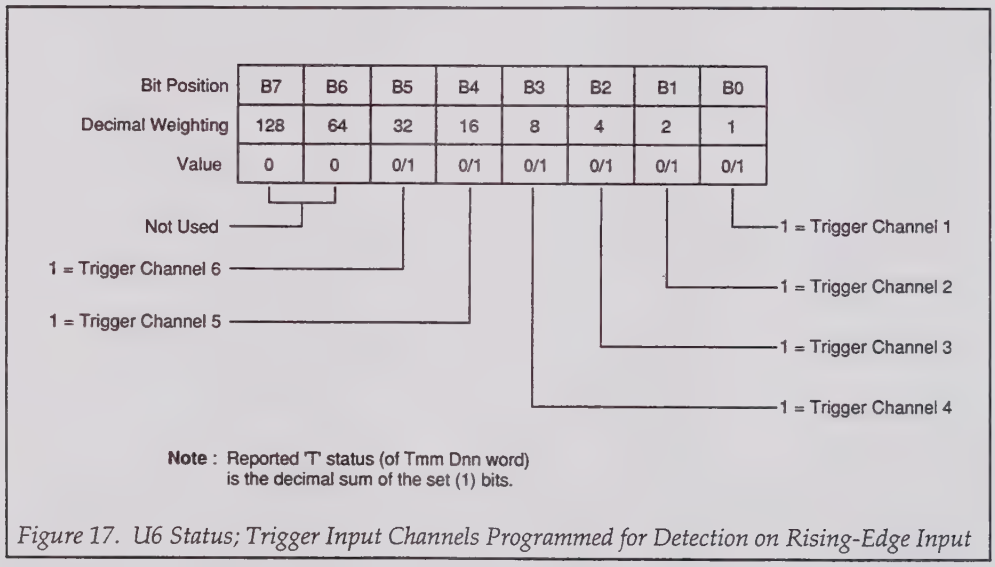


Figure 17. U6 Status; Trigger Input Channels Programmed for Detection on Rising-Edge Input

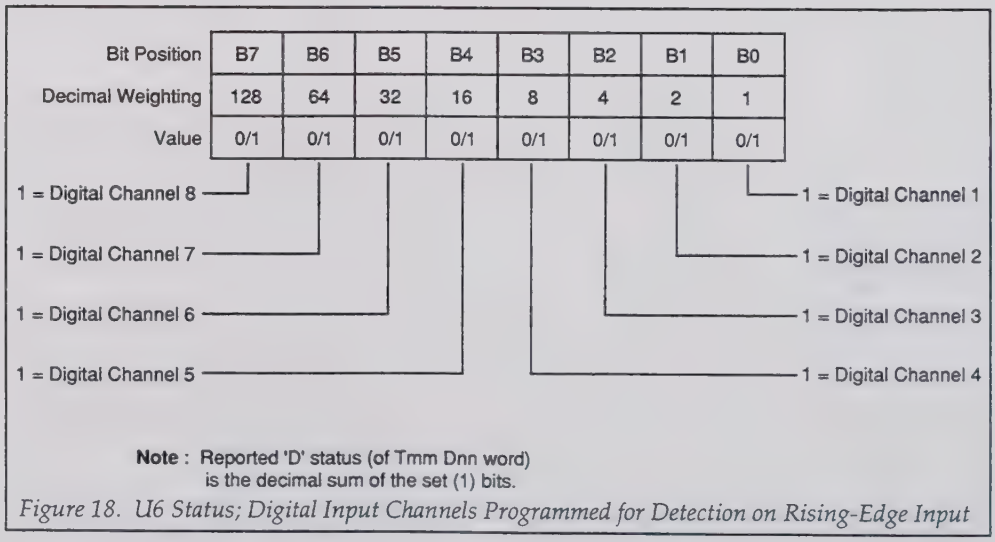


Figure 18. U6 Status; Digital Input Channels Programmed for Detection on Rising-Edge Input

For example, the U6 status word T03D000 indicates that trigger channels 1 and 2 are programmed to detect rising-edge input.

U7 Send Firmware Revision Level

The U7 command is used to obtain the revision level of the instruments firmware.

Programming Notes

To send a status word (or byte) to the controller, the Model 2361 must be addressed to talk immediately after sending the desired U command. If a U command is not first sent, the current digital levels on the eight digital input lines (0-255) will instead be sent to the controller when addressed to talk.

Programming Examples

```
10  DIM Command$ [50]                  ! Dimension command string
20  DIM Status$ [50]                   ! Dimension status string
30  REMOTE 715
40  PRINT "Enter U Command"            ! Get desired U command
50  INPUT Command$
60  IF LEN(Command$)=0 THEN 120        ! Check for null
70  OUTPUT 715; Command$&"X"           ! Program with U command
80  ENTER 715; Status$                 ! Get status
90  PRINT Status$                      ! Print status
100 PRINT CHR$(128)                    ! Print blank line
110 GOTO 40                            ! Return for next U
120 END
```

W Delay

Purpose To delay the output pulse after an input expression evaluates true.

Format **Wn**

Parameters n = 0 to 255; where "n" is the delay in 500µsec increments.

Default Upon power-up, or after a DCL or SDC command, the programmable delay defaults to 0msec.

Description The W command programs a delay between the input expression evaluating true and sending the output pulse(s) specified in the corresponding output expression. The delay period equals the value of "n" times 500µsec. For example, sending W100X programs a delay of 50msec (100 × 500µsec = 50msec).

Programming Examples

```
OUTPUT 715;"W20X"          ! Delay 10msec
OUTPUT 715;"W0X"           ! Clear delay
```

X Execute

Purpose Execute DDC's or create an active program.

Format X

Parameters none

Description The execute command is implemented by sending an ASCII "X" over the bus. Its purpose is to direct the unit to execute all device-dependent commands received since the last X. Also, a user defined I/O program is created by using the X command.

Programming Examples

```
OUTPUT 715; "M32X"      ! Execute M command
OUTPUT 715; "I0"        ! Send I0 command
OUTPUT 715; "X"         ! Execute I0 command
OUTPUT 715; "1>2X"      ! Create program; if channel 1
                          triggered, trigger out on channel 2.
```

Y Terminator

Purpose

To select the ASCII terminator sequence that marks the end of the instrument's data string.

Format

Yn

Parameters

Y0 <CR><LF>
Y1 <LF><CR>
Y2 <CR>
Y3 <LF>

Default

The default terminator on power-up, or a SDC or DCL command is Y0.

Description

By using the Y command, you can program the number and type of terminator character(s) the instrument sends at the end of its data string. Available terminator characters are the commonly used CR (carriage return, ASCII 13) and LF (line feed, ASCII 10) characters.

These terminators are recognized by most controllers. Selecting the wrong terminator for the controller could cause the bus to hang.

Programming Examples

```
OUTPUT 715; "Y1X"          ! Terminate on LF CR
OUTPUT 715; "Y0X"          ! Terminate on CR LF
```

Z Clear All Programs

Purpose To clear all programs from EEPROM.

Format **Z0**

Parameters none

Description The Z command clears all programs from EEPROM. The memory can contain up to three user programs. The Z command has no effect on the currently active program (stored in RAM).

Programming Examples

```
OUTPUT 715;"Z0X"          ! Clear all programs from EEPROM memory
```

1.8 SERVICE INFORMATION

1.8.1 Ordering Information

To obtain information concerning replacement parts, contact your Keithley representative or the factory. See the inside front cover for addresses. When ordering replacement parts, include the following information:

- Instrument model number
- Instrument serial number
- Parts description
- Circuit designation (if applicable)

1.8.2 Factory Service

If the instrument is to be returned to the factory for service, please complete the service form, which follows this appendix, and return it with the instrument.

WARNING

The servicing procedures included in this appendix are for use by qualified service personnel only. Do not perform these procedures unless qualified to do so. Never open the Model 2361 case while it is connected to the AC line. Internal voltage potentials exist which could cause personal injury or death.

1.8.3 Line Voltage Selection

The Model 2361 may be operated from 90-125V or 180-250V, 50-60Hz AC. The operational voltage is set by an internal switch (S101). The trigger controller was shipped from the factory set for the operating voltage marked on the rear panel. To change the operating voltage, it is necessary to open the enclosure and change the setting of S101 according to the following instructions:

WARNING

Disconnect the power cord from the AC line and from the Model 2361. Disconnect any cables prior to disassembly. Never open the case while it is connected to the AC line. Internal voltage potentials exist which could cause injury or death.

1. Place the trigger controller on a flat surface. Remove the eight screws on top of the case and remove the top cover. Located next to the main power supply transformer is the line voltage selection switch S101.
2. Insert the tip of a small screwdriver into the slot of the switch and move the switch to the left or right so that the desired line voltage selection appears on the switch.
3. Install a power line fuse appropriate for the line voltage. See the following paragraph for the fuse replacement procedure.
4. Make a note of the new voltage setting on the rear panel of the trigger controller and carefully reassemble the unit.

1.8.4 Fuse Replacement

The Model 2361 contains an internal AC line fuse. The fuse is located next to the internal line voltage switch (S101). This fuse may be replaced by using the following procedure:

Table 5. Line Fuse Values

Line Voltage	Fuse Type	Keithley Part No.
105-125V	1/8A, 250V, 3AG, Slo Blo	FU-20
180-250V	1/16A, 250V, 3AG, Slo Blo	FU-21

WARNING

Disconnect the power cord from the AC line and from the Model 2361. Disconnect any cables prior to disassembly.

1. Turn off the power and disconnect the line cord and all other cables from the unit.
2. Place the unit on a flat surface. Remove the eight screws on top of the case and remove the top cover.
3. The fuse is located next to the line voltage selection switch (S101). Gently pull upward on the plastic fuse housing until it separates from the fuse holder on the pc board.
4. Open the fuse housing by pushing up on the tab on the bottom of the housing.
5. Remove the fuse, and replace it with the proper type using Table 5 as a guide.

CAUTION

Do not use a fuse with a higher rating than specified or instrument damage may occur. If the instrument repeatedly blows fuses, locate and correct the cause of the trouble before replacing the fuse.

6. Close the housing and insert it into the fuse holder.
7. Make note of the fuse rating for later reference and carefully re-assemble the unit.

1.8.5 Schematic, Component Layout and Replaceable Parts

The schematic and component layout drawing are shown following the parts list.

Model 2361 Digital Board, Parts List

Circuit Desig.	Description	Keithley Part No.
	FUSE HOLDER	FH-29
	CONN,MALE,5 PIN	CS-288-5
	FUSE CLIPS	FH-12
C100,101	CAP,22PF,20%,500V,CERAMIC	C-22-22P
C102,103	CAP,1UF,20%,50V, CERAMIC	C-237-1
C104	CAP,4700UF, -10%+100%,16V, ELECTROLYTIC	C-290-4700
C105	CAP, 10UF,-20+100%,25V,ALUM ELEC	C-314-10
C106..138	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
CR100..155	DIODE,SILICON,IN4148 (DO-35)	RF-28
CR156	DIODE, BRIDGE PE05	RF-48
DS100..116	PILOT LIGHT RED, HI-INTENSITY LED	PL-88-1
F100	(FU-21 1/16A FOR EUROPE) FUSE, .125A, 250V,3AG SLO-BLO	FU-20
J1002	CONN,RIGHT ANGLE,24 PIN	CS-501
J1004..1015	CONN, BNC	CS-547
J1016	MODIFIED CONNECTOR	236-329
R100..127	RES,100,5%,1/4W,COMPOSITION OR FILM	R-76-100
R128..149	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
R150	RES,10M,5%,1/4W,COMPOSITION OR FILM	R-76-10M
R151..167	RES,3.3K,5%,1/4W, COMPOSITION OR FILM	R-76-3.3K
R168	RES, 33, 5%,1/4W, COMPOSITION OR FILM	R-76-33
R169..185	RES,390,5%,1/4W,COMPOSITION OR FILM	R-76-390
S100	SWITCH,PUSHBUTTON (6 POLE)	SW-466
	PUSHBUTTON, RED	29465-3
S101	SWITCH, SLIDE (DPDT)	SW-484
S102	SWITCH, HORIZONTAL MOUNT, DIP, SPST	SW-449-8
T100	TRANSFORMER	TR-275
U100	IC,8-BIT MICROCONTROLLER,MC68HC11F1	LSI-98
U101	IC,GPIB ADAPTER,9914A	LSI-49
U102	EPROM PROGRAM	2361-800-**
U103	IC, SUPPLY VOLTAGE SUPERVISOR, TL7709AC	IC-715
U104..107	IC, QUAD 2 INPUT MULTI, 74HCT257	IC-709
U108..114	IC, QUAD 2 INPUT EXCLUSIVE-OR, 74HCT86	IC-707
U115..122	IC, OCTAL D-TYPE FLIP-FLOP, HCT574	IC-629
U123..129	IC,DUAL D FLIP FLOP W/SET & RESE,74HCT74	IC-515
U130	IC,DECODER/DEMUX,74LS138	IC-182
U131	IC,OCTAL INTERFACE BUS TRANSCEIVER,75161	IC-299
U132	IC,OCTAL INTERFACE BUS,75160	IC-298

**ORDER CURRENTLY INSTALLED FIRMWARE REVISION LEVEL.

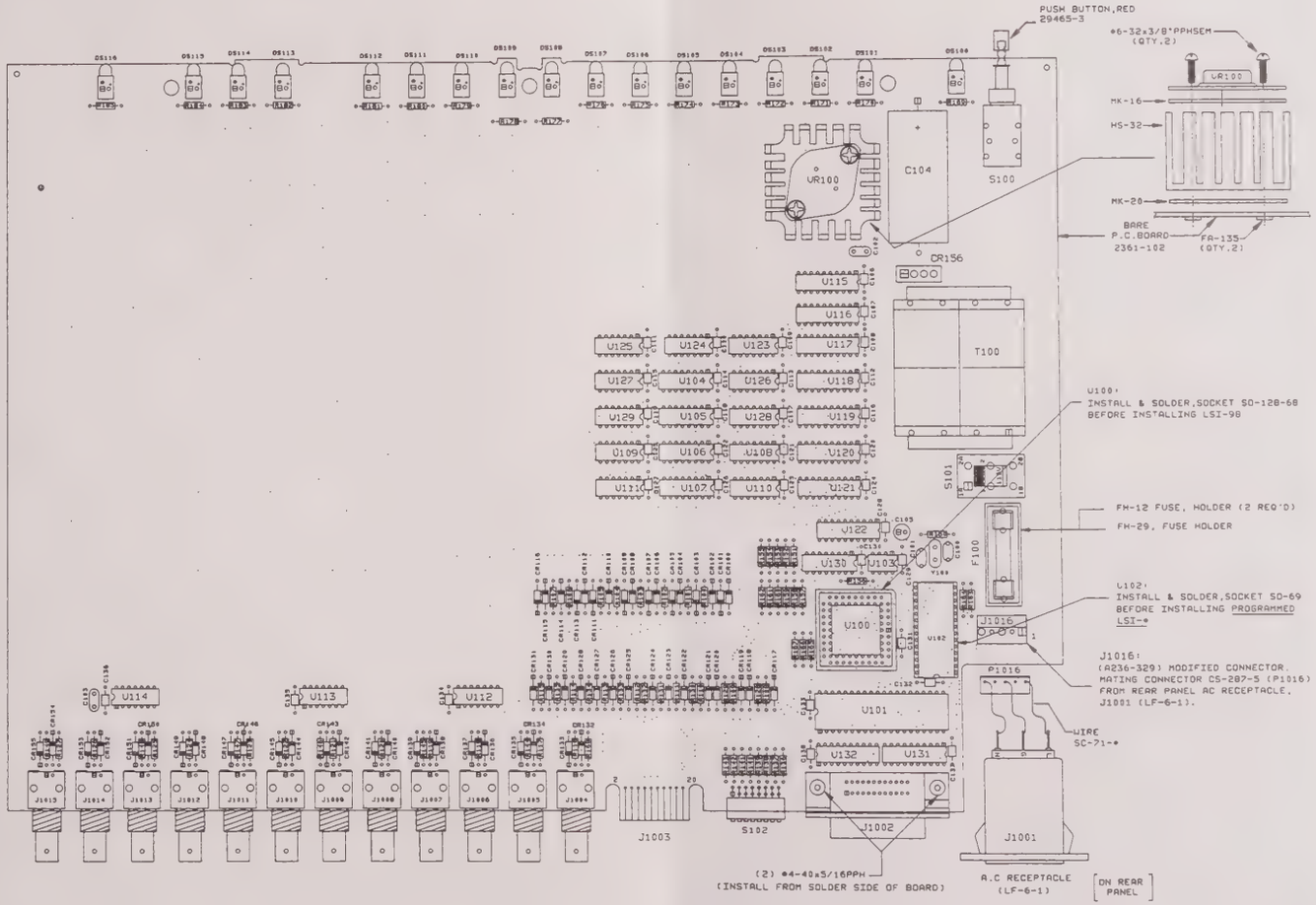
	4-40X5/16 PHILLIPS PAN HD	4-40X5/16PPH
	6-32 PEM NUT	FA-135
	6-32X3/8 PHILLIPS PAN HD	6-32X3/8PPH
	SOCKET,I.C. 28 PIN	SO-69
	SOCKET, 68-PIN QUAD	SO-128-68
VR100	IC, POS VOLTAGE REG +5V,500MA,309	IC-34
	HEAT SINK	HS-32
	MOUNTING KIT	MK-20
	MOUNTING KIT	MK-16
Y100	CRYSTAL,8.0000MHZ	CR-24-1

Model 2361 Mechanical, Parts List

Description	Keithley Part No.
BNC TO BNC CABLY ASSEMBLY	CA-19-1
CONNECTOR CARD EDGE	CS-444-2
COVER, TOP AND BOTTOM	2361-307A
DIGITAL BOARD TO FRONT PANEL BRACKET	2361-313A
FEET	FE-24-1
FRONT PANEL	2361-304A
GND LUG	LU-88
HOUSING, CONNECTOR	CS-287-5
IEEE MTG HARDWARE	CS-378
KEY	CS-474
LINE FILTER	LF-6-1
OVERLAY, FRONT PANEL	2361-303B
POWER CORD	CO-19
P1016 CONNECTOR	CS-276
P1016 POLARIZING KEY	CS-345
RACK EAR	2361-311A
REAR PANEL	2361-306C
SELF-TEST CONNECTOR	2361-314B
SIDE PANEL	2361-308A
SPACER PLATE	2361-309A
TINNERMAN CLIP	FA-231-1
1/2-28 UNEF SMALL NUT	FA-234-1

LTR.	ECO NO.	REVISION	ENG.	DATE
A		PRELIMINARY		1-15-90
B	900321	RELEASED		3-21-90
C	14007	REVISED AND REDRAWN		4-9-90
D	14377	REVISED		5-1-90

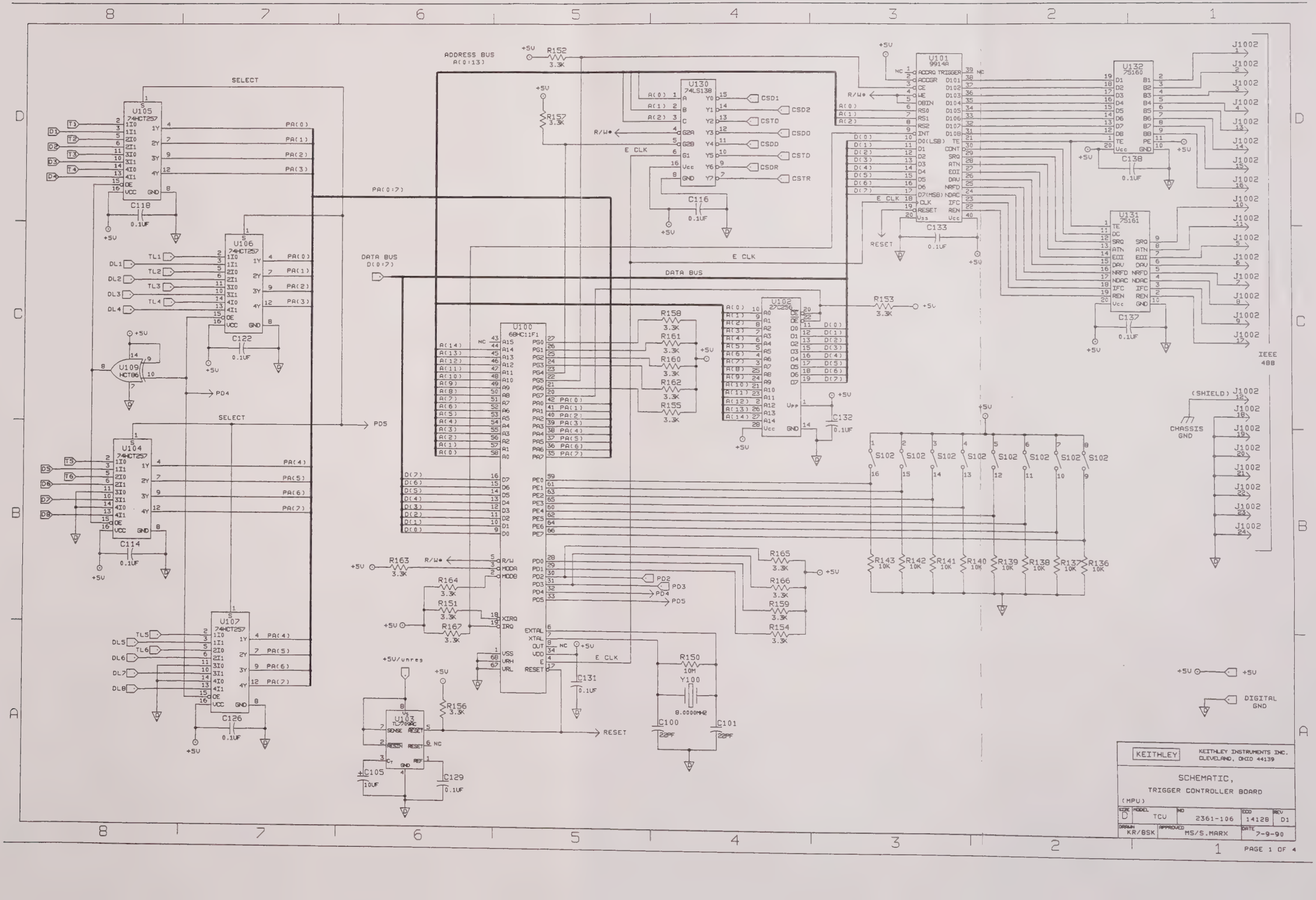
NO. 2361-100

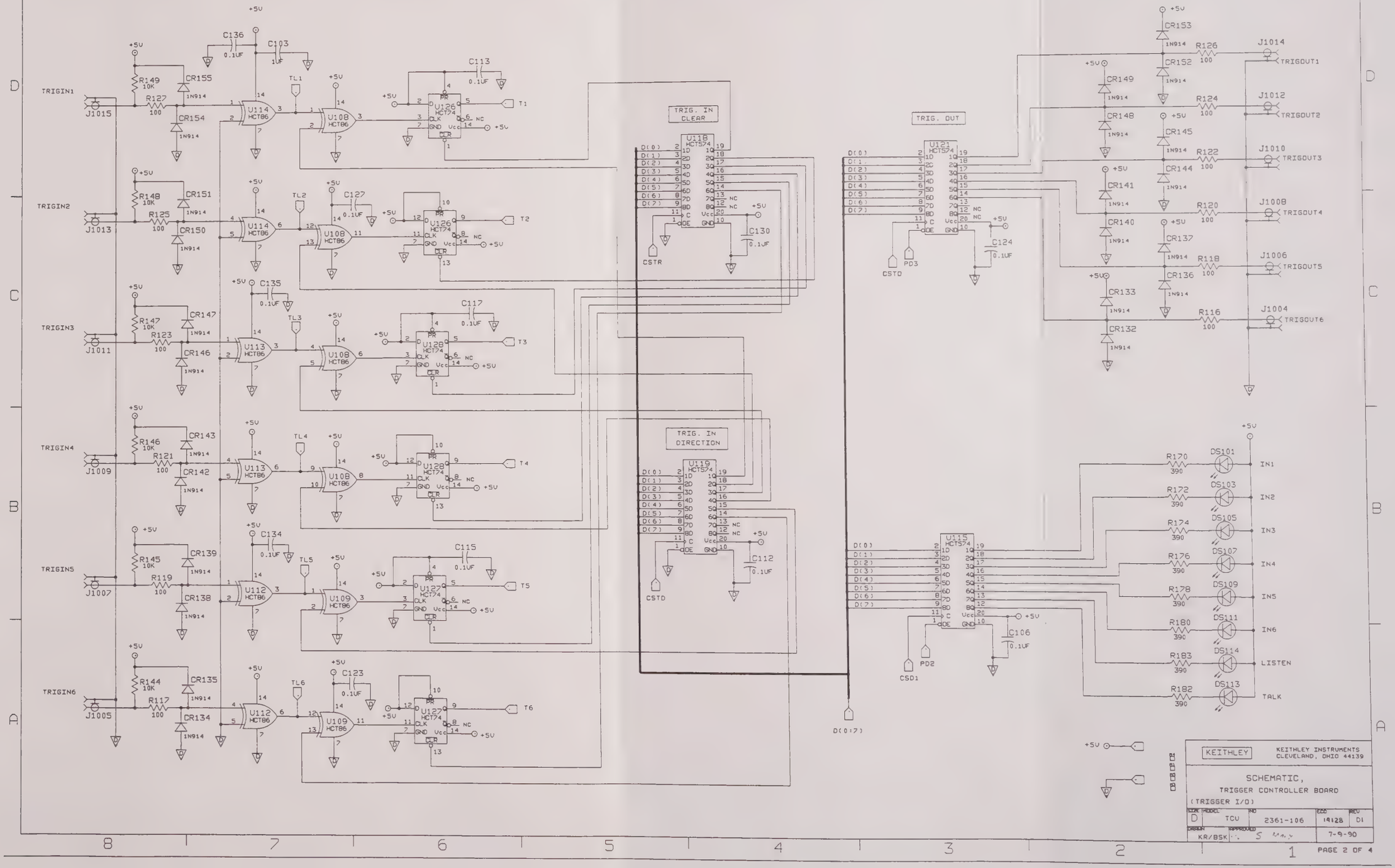


NOTE:
FOR COMPONENT INFORMATION,
SEE PRODUCT STRUCTURE.

2361					
MODEL	NEXT ASSEMBLY	QTY.			
USED ON					

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 4-23-90	SCALE 1:1	TITLE COMPONENT LAYOUT,
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XX=± 015 ANG =±1°	DRN. BSK	ENG. APPR.	TRIGGER CONTROL UNIT (TCU)
	XXX=± 005 FRAC.=±1/64	MATERIAL		D NO. 2361-100
	SURFACE MAX. 63	FINISH		


SELECT
U105 74HCT257
PA(0)
PA(1)
PA(2)
PA(3)
C118 0.1UF
U106 74HCT257
C122 0.1UF
U109 HCT86
PD4
PD5
U104 74HCT257
PA(4)
PA(5)
PA(6)
PA(7)
C114 0.1UF
U107 74HCT257
C126 0.1UF
ADDRESS BUS A(0:13)
DATA BUS D(0:7)
PA(0:7)
R152 3.3K
R157 3.3K
U130 74LS138
CSD1
CSD2
CSTD
CSDO
CSDD
CSTD
CSDR
CSTR
C116 0.1UF
E CLK
R/W*
DATA BUS
U100 68HC11F1
R158 3.3K
R161 3.3K
R160 3.3K
R162 3.3K
R155 3.3K
U102 27C256
R153 3.3K
C132 0.1UF
R163 3.3K
R164 3.3K
R151 3.3K
R167 3.3K
R165 3.3K
R166 3.3K
R159 3.3K
R154 3.3K
+5V/unreg
U103 TL7705AC
R156 3.3K
+C105 10UF
C129 0.1UF
RESET
C131 0.1UF
R150 10M
Y100 8.0000MHZ
C100 22PF
C101 22PF
U101 9914A
C133 0.1UF
U132 75160
C138 0.1UF
U131 75161
C137 0.1UF
IEEE 488
(SHIELD)
CHASSIS GND
S102
R143 10K
R142 10K
R141 10K
R140 10K
R139 10K
R138 10K
R137 10K
R136 10K
DIGITAL GND
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139
SCHEMATIC,
TRIGGER CONTROLLER BOARD
(MPU)
SIZE D
MODEL TCU
NO 2361-106
ECO 14128
REV D1
DRAWN KR/BSK
APPROVED MS/S.MARX
DATE 7-9-90
PAGE 1 OF 4



KEITHLEY — KEITHLEY INSTRUMENTS CLEVELAND, OHIO 44139

SCHEMATIC,
TRIGGER CONTROLLER BOARD
(TRIGGER I/O)

SIZE	MODEL	NO	ECO	REV
D	TCU	2361-106	18128	D1
DRAWN	APPROVED			
KR/BSK			7-9-90	

DIGIN1 DIGIN2 DIGIN3 DIGIN4 DIGIN5 DIGIN6 DIGIN7 DIGIN8

DIGITAL IN CLEAR

DIGITAL IN DIRECTION

DIGITAL OUT

DIGOUT1 DIGOUT2 DIGOUT3 DIGOUT4 DIGOUT5 DIGOUT6 DIGOUT7 DIGOUT8

OUT1 OUT2 OUT3 OUT4 OUT5 OUT6 REMOTE ERROR

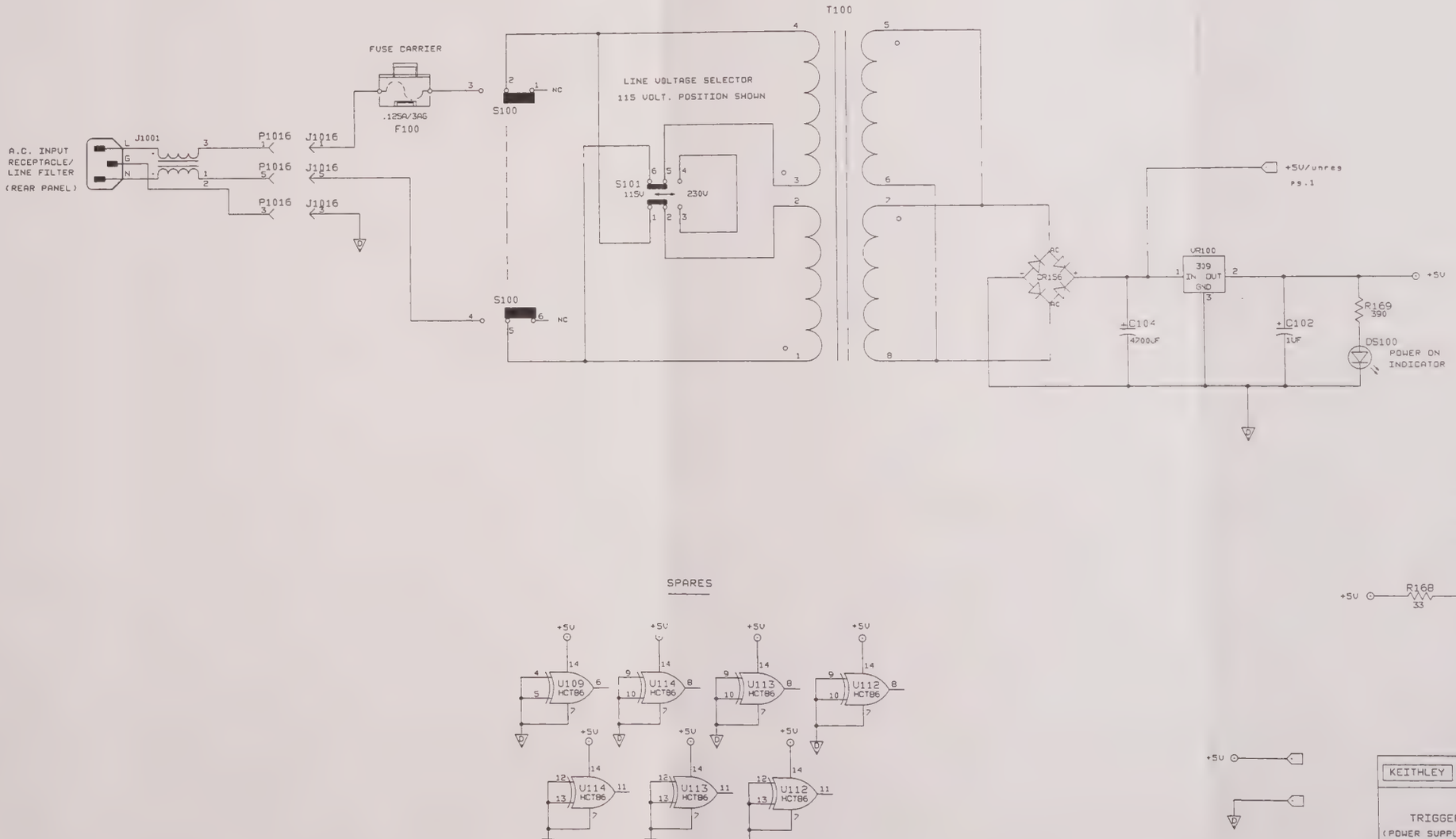
KEITHLEY

KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

SCHEMATIC,
TRIGGER CONTROLLER BOARD
(DIGITAL I/O)

SIZE	MODEL	NO	ECO	REV
D	TCU	2361-106	14128	D1

DRAWN KR/BSK APPROVED S. Mary DATE 7-9-90



KEITHLEY	KEITHLEY INSTRUMENTS CLEVELAND, OHIO 44139
SCHEMATIC, TRIGGER CONTROLLER BOARD (POWER SUPPLY)	
SIZE: D	MODEL: TCU
NO: 2361-106	ECO: 14128
REV: D1	
DRAWN: KR/BSK	APPROVED: S Murphy
DATE: 7-9-90	

KEITHLEY

Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

- ❑ Intermittent
- ❑ IEEE failure
- ❑ Front panel operational
- ❑ Analog output follows display
- ❑ Obvious problem on power-up
- ❑ All ranges or functions are bad
- ❑ Particular range or function bad; specify _____
- ❑ Batteries and fuses are OK
- ❑ Checked all cables

Display or output (check one)

- ❑ Drifts
- ❑ Unstable
- ❑ Overload
- ❑ Unable to zero
- ❑ Will not read applied input

- ❑ Calibration only
- ❑ Data required
- ❑ Certificate of calibration required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

1. What other Keithley products do you currently use?

2. What effects, devices or phenomena do you measure with this instrument?

3. What was the main reason a *Keithley* unit was purchased?

4. Do you have any design suggestions concerning this unit?

PLEASE REFOLD SO YOUR NAME IS INSIDE, TAPE AND MAIL.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
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